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29 April, 1993

Dr. Tomas B. Curtin
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Dear Tom:

Enclosed is the Annual Technical Report for the past year. I have not included a lot of detail because of our extensive communications, and because of your recent visit. If more detail or a different format is desired, either can certainly be accommodated.

I hope your return to Washington was uneventful, and enjoyed to opportunity to visit with you. Next time I will be in better physical condition.

Sincerely,

F. Yates Sorrell
Professor

Xc: Dr. Norman A. Meeks, ONR Resident Representative
Director, Naval Research Laboratory
Defense Technical Information Center (2)

ICE -OCEAN FOUR DIMENSIONAL STRUCTURE AND DYNAMICS

Annual Technical Report for The Period
31 March 1992 to 31 March 1993

Project Title: Ice-Ocean Four Dimensional Structure and Dynamics
Principal Investigator: F. Y. Sorrell
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Grant No.:N00014-90-J-4128-P3
Start/End Dates: 9 Sept. 1990 - 31 March 1995

OBJECTIVES

To understand the relationship among underice morphology, ice thickness and the structure of the oceanic boundary layer, an Autonomous Oceanographic Sampling Network is being developed. Each network consists of a base buoy and a number of Autonomous Oceanographic Vehicles (AOVs) at fixed levels. The base buoy serves as a navigation beacon, energy source, telemetry link and surface sensor platform. Each AOV functions as a subsurface sensor platform, short term data logger and programmable, navigable vessel. Development of system components capitalizes on advanced microprocessors, navigation and communication systems developed by DOD and industry for buoy and vessel technology. The first step will be to produce an AOV that has acceptable performance as a subsurface platform and which can dock with the base buoy and conduct data exchange.

APPROACH

The most immediate task has been to develop a suitable AOV. Early work attempted to adapt an expendable mine destructor as the subsea platform. Initial tests proved the concept for such a vehicle, and tested acoustic homing. The expendable mine destructor, however, did not have sufficient flexibility to meet all of the desired AOV functions. Therefore, it was deemed necessary to design and construct a suitable subsurface platform to serve as the AOV. This consists of design, construction and testing of a prototype AOV, including control systems and vehicle dynamics to provide suitable docking capability. It also includes development of appropriate sensor suits, data acquisition and storage systems, and integration of these systems into the vehicle payload. Finally, docking and interface connections to a suitable buoy system, consisting of data up-links and power transfer for recharging are to be developed and demonstrated.

TECHNICAL ACCOMPLISHMENTS

The major effort during this period has been to develop a suitable subsea platform to serve as the AOV. After the expendable mine destructor was discarded, an alternative vehicle configuration was developed. This is 28 cm dia (10.75 inch) cylindrical shape with an overall length of 1.4 m (4.5 ft). The design of this vehicle has been completed, and a single prototype constructed. This prototype will take several different propulsion systems, to permit early evaluation of performance of the different propulsion systems. The design includes the initial control system, including control actuators and control surfaces.

Preliminary system payload requirements, consisting of an onboard computer, data acquisition and storage system, and sensor interface have been designed and constructed. The system has completed initial testing. An integrated power supply system, to supply power to both the payload and the propulsion system, has been developed.

This prototype has undergone a single wet test, to date, as a proof of concept evaluation. The AOV was operated underwater using a remote computer link to operate the vehicle control system and to the control the thrustor. In this test all components, e.g. control system, thrustor, and onboard computer controller and data acquisition/storage sub-systems operated satisfactorily. Preliminary evaluation indicates adequate response of the vehicle to control motions, real time control of the vehicle, and satisfactory operation of the data sub-systems.

Acoustic homing was demonstrated during the prior year, using the expendable mine destructor. This system worked in preliminary tests, but extensive modifications would have been required to adapt it to the present homing application. An alternative approach, using magnetic homing has been designed, constructed and tested. Bench tests have been successful, and will be evaluated during the next wet tests with the prototype.

In addition to tests of the magnetic homing system, the next wet tests will evaluate vehicle docking feasibility. Also planned are onboard sensors to measure the AOV motion during testing. These data will be recorded by the data sub-system, and will be used to evaluate vehicle response to control inputs, as well as to test the data acquisition and storage sub-systems. These wet tests are planned for summer 1993.

PERSONNEL:

Evaluation of the Acoustic homing system was performed by Bendix Oceanics, inc. under sub-contract from NCSU. The test were conducted by Bendix using their Expendable Mine Destructor (EMD). Results from these tests are indicated above. The on-board computer systems for vehicle control, and for data acquisition and storage were designed, constructed and tested under sub-contract from NCSU by Electronic Design Consultants (EDC). The prototype AOV design and construction was done at NCSU. The effort was directed by the PI, however much of the work was done as an undergraduate design project in the Department of Mechanical and Aerospace Engineering at NCSU. This effort was

also helped in the later stages by James Jewell, who is a graduate student in the MAE dept. Mr. Jewell was supported by the department during fall semester 1992, and by an ASSERT grant during spring semester 1993. He will continue to be supported with ASSERT funding. The working relationship between EDC and NCSU has been good, and we plan on a continued joint effort.

SUB-CONTRACTORS:

A section on the sub-contractors is included in the technical report because of the sub-contracts to Bendix Oceanics and Electronic Design Consultants (EDC), and some changes in these sub-contracts. The original plan called for short range testing of the acoustic homing system for $58,000 and if successful, long range testing for an additional $25,000. This was to be accomplished by a sub-contract to Bendix and $30,000 was paid at the start of program to initial the acoustic work. The long range acoustic testing was never attempted and the $25,000 planned for this task had been added to the sub-contract to EDC for work on the magnetic homing system and prototype development of the on-board computer system. Although a demonstration of the short range acoustic homing was demonstrated by Bendix using the EMD, a report on the effort, as required in the sub-contract, was never submitted. The remaining $28,000 has thus not been expended. It is planned that these funds will be re-directed to ongoing tasks in sensor and docking development, and in wet testing.

The work in docking configuration for data and power transfer were carried out by EDC prior to this years work. This work also include design and construction of the docking cone. During this past year EDC provided support for the on-board computer system. This work was divided into three Tasks:

1. Define Sensor Systems Payload requirements. This included design of the sensor data acquisition/storage system in order to precisely define the payload requirements.

2. Evaluate and Construct a Prototype Electromagnetic Homing System

3. Construct and Test the Vehicle Control and Propulsion Systems

All of this work was completed satisfactorily.